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Results of SSFATE Model Simulations, Nearshore Connecticut, Long Island Sound

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Introduction

Islander East Pipeline Company, LLC (Islander East) is seeking permits to install a 24-inch diameter natural gas pipeline from near Branford, Connecticut to Wading River, New York under Long Island Sound. The pipeline installation will require a series of different construction techniques. Horizontal directional drilling from the Connecticut shore to a transition basin below the seabed will extend 4,200 feet. This transition basin will be constructed using a clamshell bucket dredge. Under one option being considered, the dredged material will be placed on barges and stored until completion of the pipeline installation. The basin will remain open for approximately 3 weeks and then be refilled with the stored material. South of the basin a pipeline trench will be constructed, again with a clamshell bucket dredge. The trench will extend approximately 5,581 feet further offshore, and under two proposed options, provide either 18 inches or 3 feet of cover over the pipeline. The option for 18 inches of cover over the pipeline would require dredging 27,840 yd^3 of material from the basin and trench. Installing the pipeline with three feet of cover would require 55,000 yd^3 total dredge volume. The trench is scheduled to remain open for approximately three weeks, and then be refilled. All dredged material will be placed on barges. Offshore beyond the dredged trench, a mechanical plow will be used to create a trench across Long Island Sound. Additional details about the geometries of the basin and trench can be found in Bohlen et al. (2002).

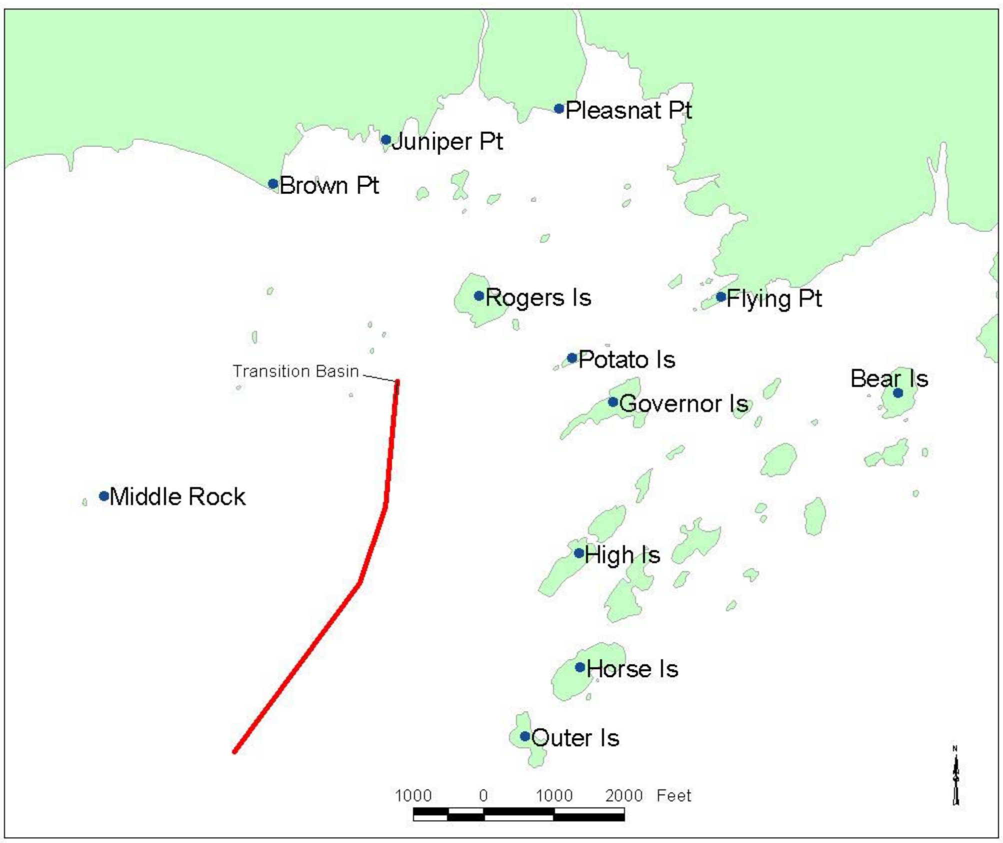

Figure 1. Location of proposed dredged transition basin and trench section with respect to the Connecticut shoreline. The portion of the trench modeled in SSFATE is shown with the heavy red line. The transition basin is located at the northern end of the trench section depicted.

The SSFATE Model

This report presents the results of SSFATE model simulations of the dredging operations required to excavate the transition basin and the pipeline trench. SSFATE (Suspended Sediment FATE) computes suspended sediment distributions resulting from both dredging and jetting operations. SSFATE is a versatile computer modeling system containing the following features:

- Ambient currents can either be imported from a numerical hydrodynamic model or drawn graphically using interpolation of limited field data,
- Computational model predicts the transport, dispersion, and settling of suspended dredged material released to the water column using a random walk procedure,
- The model simulates sediment source strength and vertical distribution from cutterhead, hopper, or clamshell type dredges,
- Multiple sediment types or fractions can be simulated simultaneously,
- Model outputs consist of concentration contours in both horizontal and vertical planes, time series plots of suspended sediment concentrations, and the spatial distribution of sediment deposited on the sea floor,
- Sediment particle movement and concentration evolution can be animated over Geographic Information System (GIS) layers depicting sensitive environmental resources and areas.

The Hydrodynamic Model

The SSFATE model simulations were run using tidal currents generated using a hydrodynamic model (HYDROMAP) developed by ASA. HYDROMAP is a globally re-locatable hydrodynamic model (Isaji, et al., 2001a, 2001b) capable of simulating complex circulation patterns due to tidal forcing, wind stress and fresh water flows quickly and efficiently anywhere on the globe. HYDROMAP employs a novel step-wise-continuous-variable-rectangular gridding strategy with up to six levels of resolution. The term step-wise continuous implies that the boundaries between successively smaller and larger grids are managed in a consistent integer step. HYDROMAP has been applied in particle transport studies in Indonesia, Malaysia, Singapore and the northeast coast of the US. The numerical solution methodology follows that of Davies (1977) and Owen (1980). The interested reader is directed to Isaji, et al. (2001a, 2001b), and Isaji and Spaulding (1984) for a detailed description of the model.

Tides are the predominant force in Long Island Sound and were used for generating the current field used in this study. The wind events generating currents and waves capable of sediment transport occur infrequently and it is assumed that dredging operations will not occur under these conditions, and so tidal current forcing is used exclusively. Tidal currents in the Long Island Sound region are predominantly semidiurnal. The M2 amplitude is greater than the second largest constituent by a factor of 4.5 and the currents generated by the hydrodynamic model contain only the M2 constituent. The M2 tidal constituent also represents the most typical current velocity on a daily basis.

The hydrodynamic model domain includes the central portion of Long Island Sound. Figure 2 shows the current field in the dredge operation area for a single time during the tidal cycle.

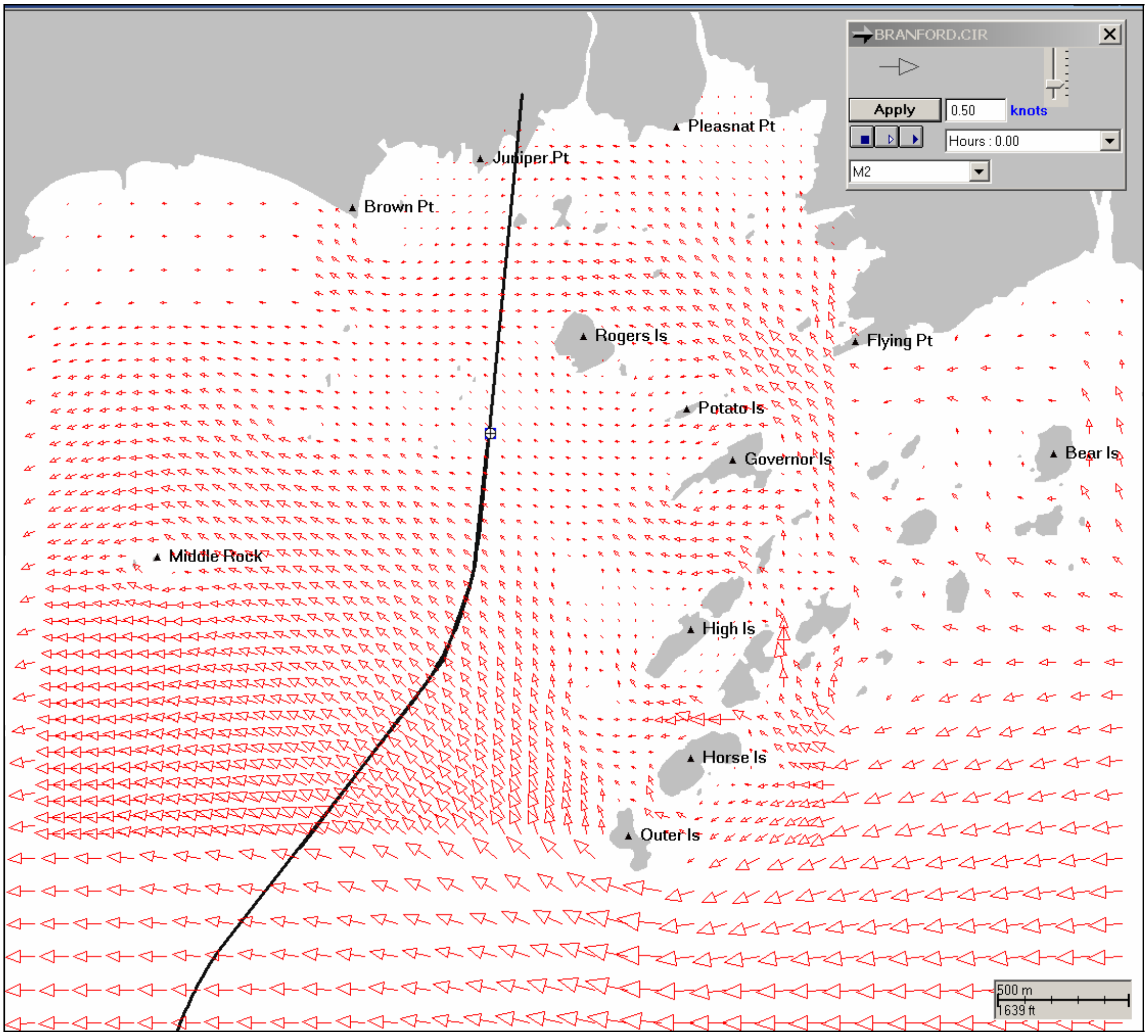

Figure 2. Snapshot of the tidal current field in the area of the dredging operations generated from the hydrodynamic model. Vectors indicate current speed and direction and are scaled to the 1-knot index vector at the top right corner of the map. The heavy black line depicts the proposed pipeline route.

SSFATE Results

The results from two SSFATE simulations are presented as maps showing the sediment footprint predicted to result from dredging the transition basin and the trench. The simulations model a 12-yd^3 clamshell dredge working continuously at a rate of 480 yd^3/hour. The model assumes a 3 percent loss of material as the material is picked up from the bottom, lifted through the water column and placed in the barge. An additional 1 percent of material is lost from the barge due to overfilling. Table 1 summarizes the input parameters and results from the SSFATE simulation of the 27,840 yd^3 of total dredge material associated with the 18 inch pipeline cover option.

Table 1. Summary of the model parameters and results for the 27,840 yd^3 option.

Loss from Dredge (percent)	Loss from Barge (percent)	Area Covered by Greater Than 1mm from the Transition Basin (Acres)	Area Covered by Greater Than 1mm from the Trench (Acres)	Total Area Covered by Greater Than 1mm (Acres)	Area Covered by Greater Than 3mm (Acres)
3	1	8.4	5.6	14.0	0.0

Figure 3 shows the sediment deposit from the 27,840 yd^3 dredging operation corresponding to the 18 inches of cover over the pipeline. The sediment deposit oscillates to either side of the trench due to the tidal current reversals that occur over the 58-hour dredging operation. As shown in table 1 and depicted in figure 3 in red and pink colors, 14.0 acres are covered by sediment with a thickness greater than 1mm. Sediment from the transition basin results in 8.4 acres of deposition greater than 1 mm. It should be noted that this area (8.4 acres) of greater than 1mm of sediment thickness entirely contains the area of excavation for the transition basin. Sediment from the trench results in an area of 5.6 acres with greater than 1 mm sediment accumulation. The maximum thickness seen in the “low volume” option is between 2 and 3mm.

Table 2 summarizes the input parameters and results from the SSFATE simulation of the 55,000 yd^3 of total dredge material associated with the 3 ft pipeline cover option.

Table 2. Summary of the model parameters and results for the 55,000 yd^3 option.

Loss from Dredge (percent)	Loss from Barge (percent)	Area Covered by Greater Than 1mm from the Transition Basin (Acres)	Area Covered by Greater Than 1mm from the Trench (Acres)	Total Area Covered by Greater Than 1mm (Acres)	Area Covered by Greater Than 3mm (Acres)
3	1	34.8	3.8	38.6	4.0

Figure 4 shows the sediment deposit from the 55,000 yd^3 dredging operation corresponding to 3 feet of cover over the pipeline. The sediment deposit from this option shows an oscillation to either side of the trench due to the tidal current reversals that occur over the 114-hour dredging operation. As shown in table 2 and depicted in Figure 4, an area of 38.6 acres is covered by sediment with a thickness greater than 1mm. An area of 4.0 acres is covered with sediment greater than 3mm thick. It should be noted that the area of greater than 1mm of sediment thickness entirely contains the area of excavation for the transition basin. The maximum thickness seen in the “high volume” option is between 5 and 7mm.

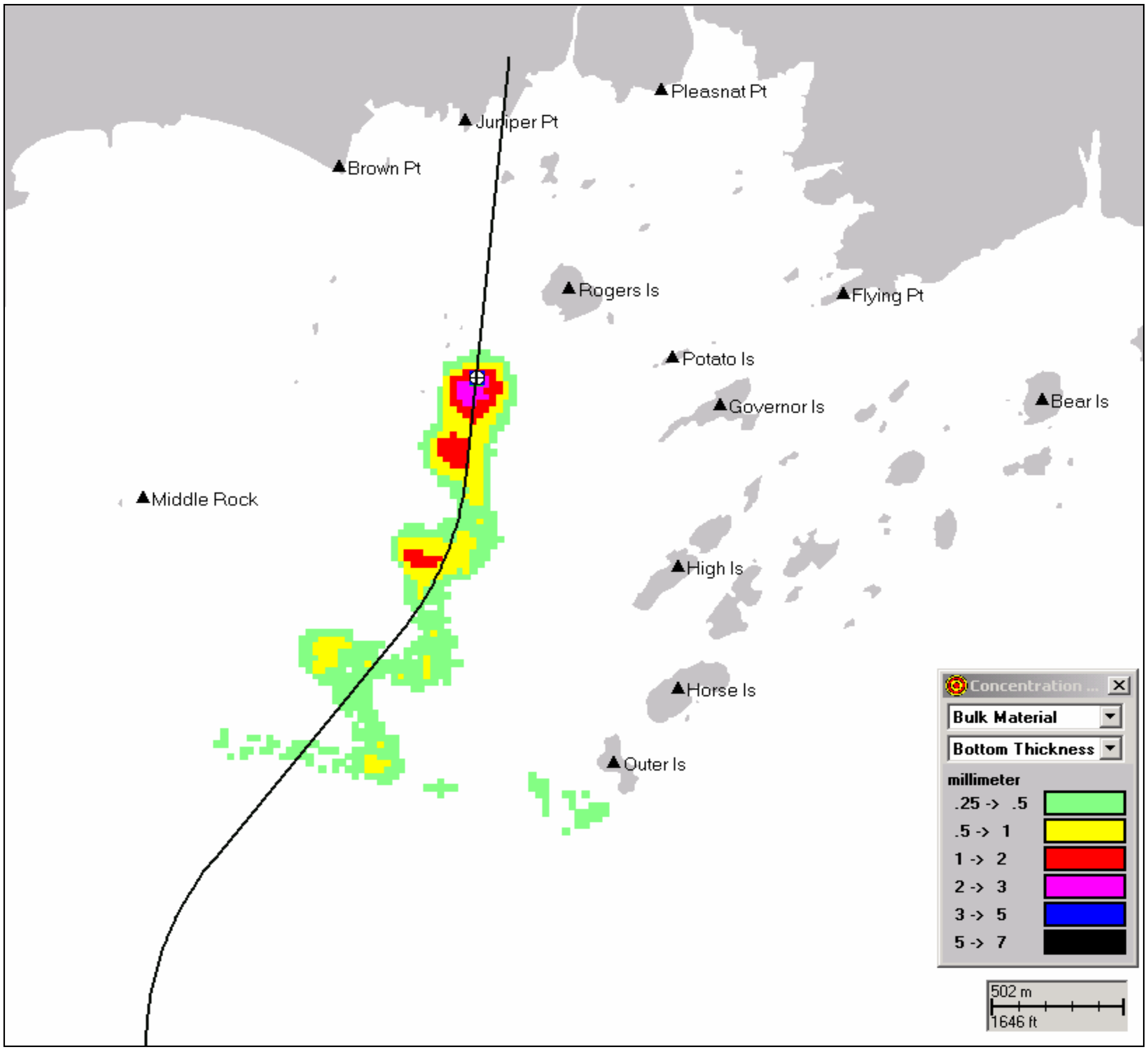

Figure 3. Map showing the predicted sediment deposit on the bottom from dredging 27,840 yd^3 from the transition basin and trench to achieve 18 inches of cover over the pipeline. Sediment thickness is in millimeters. The heavy black line depicts the proposed pipeline route.

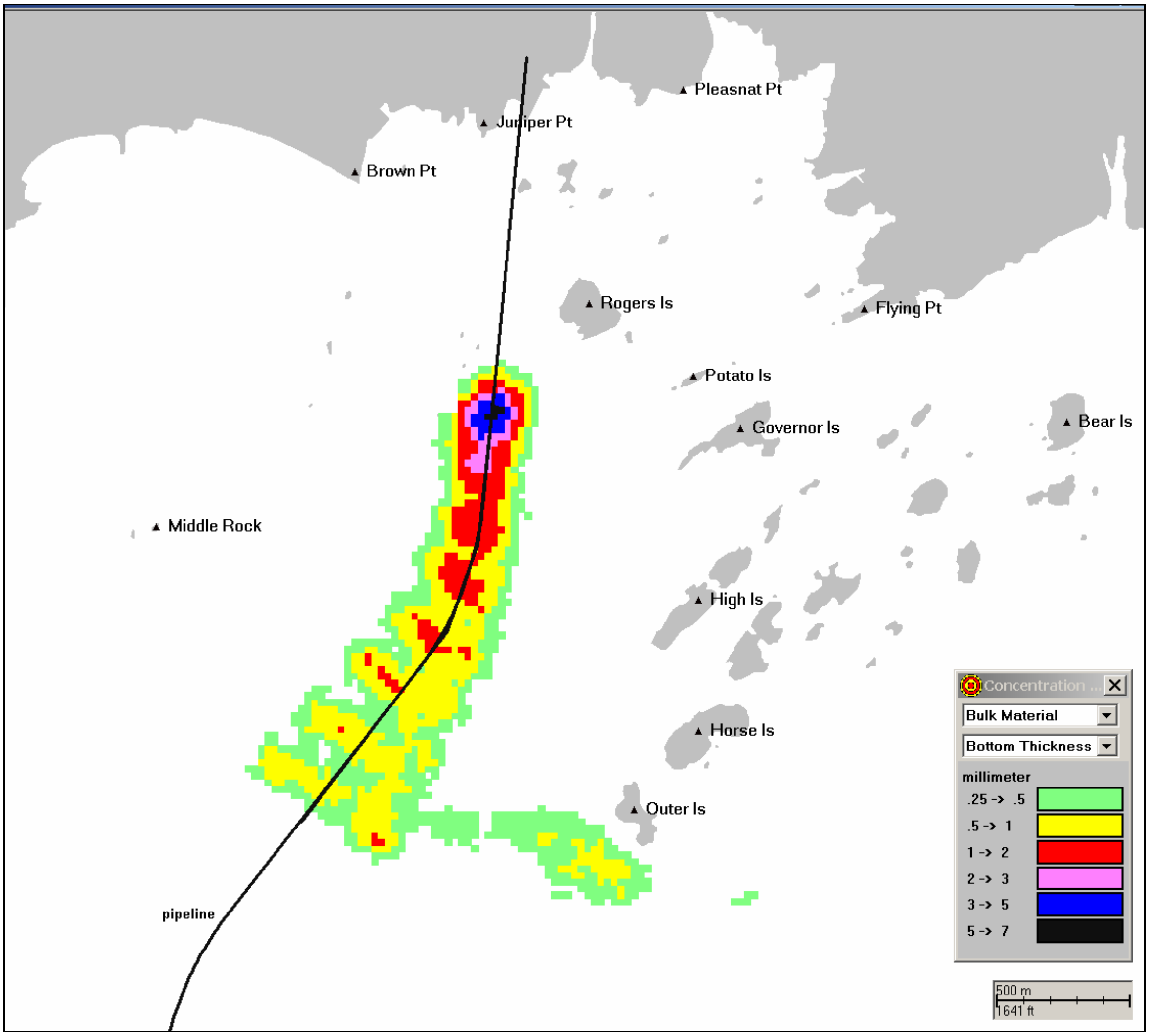

Figure 4. Map showing the predicted sediment deposit on the bottom from dredging 55,000 yd^3 from the transition basin and trench to achieve three feet of cover over the pipeline. Sediment thickness is in millimeters. The heavy black line depicts the proposed pipeline route.

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